

## SECTION M3

### BITUMINOUS MATERIALS

#### M3.00.0 General.

All bituminous materials shall conform to the requirements of the specifications as designated hereinafter.

Bitumen delivered to a project or to a mix plant must be accompanied by a proper certificate signed by the producer's authorized representative. Shipments of material *not* accompanied by a certificate *will not* be accepted for use in the work until a representative sample has been tested and approved by the Research and Materials Section of the Department.

A. Unless otherwise stipulated, the sampling of bituminous materials shall be in accordance with AASHTO T 40.

The following procedure shall be followed in obtaining samples from pressure distributors or tankers used for the transport of bituminous materials:

1. Distributors and tankers shall be equipped with approved sampling valves. The sampling valves on tankers shall be installed in the rear bulkhead approximately 1/3 of the height from the bottom. The sampling valves on pressure distributors may be located in the side of the tank somewhere in the middle third of the tank depth.

2. At least 4 liters of material shall be drained off through the sampling valve and discarded before the sample is taken.

3. Sample containers shall be new, clean and sealed with a tight fitting cap. Washing of sample containers with solvents or water will not be permitted.

B. The sampling of bituminous paving mix shall be in accordance with methods prescribed in the Department's Materials Manual.

#### M3.01.0 Asphalt Cement.

Materials of this type shall conform to AASHTO M 226, Table 2, with the additional requirement for Ductility at 15.5 °C.

#### M3.02.0 Cutback Asphalts.

These materials shall be blends of asphalt cements and suitable solvents. They shall be homogeneous, free from water and conform to the requirements of AASHTO M 81 for the rapid curing type and AASHTO M 82 for the medium curing type.

#### M3.02.1 Asphalt Primer.

This material shall be suitable for priming concrete and masonry surfaces prior to the application of waterproofing asphalt. It shall conform to the requirements of AASHTO M 116.

#### M3.03.0 Asphalt Emulsions.

These materials shall be homogeneous and shall show no separation after mixing within thirty days after delivery. They shall conform to the requirements of AASHTO M 140 with the following exception:

Viscosity determination will not be required for material sampled at point of delivery.

**TABLE 2****Specification Requirements for Asphalt Cement  
Viscosity Graded at 60°C**

		Viscosity Grade		
	AC-5	AC-10	AC-20	AC-40
Tests	Min	Min	Min	Min
Viscosity, 60 °C, Pascal-second	$5 \pm 10$	$100 \pm 20$	$200 \pm 40$	$400 \pm 80$
Viscosity, 135 °C, mm <sup>2</sup> /s	175	250	300	400
Penetration, 25 °C, 100 g, 5 Sec.	140	80	60	40
Flash Point, COC, °C	177	219	232	232
Solubility in trichloroethylene %	99.0	99.0	99.0	99.0
Tests on residue - Thin Film				
Oven Test				
Loss on Heating %	1.00	0.50	0.50*	0.50
Ductility, 15.5 °C 500 mm/min, mm	1000	400	200	
Ductility, 25 °C 500 mm/min, mm	1000	750	500	250
Maximum viscosity, 60 °C, Pascal-second	200	400	800	1600

Ductility test temperature will be specified by the Research and Materials Engineer.

\*Up to 1% if approved by the Engineer.

**M3.03.1 Cationic Emulsified Asphalt.**

This material shall be a homogeneous asphalt emulsion. It shall remain homogeneous for a minimum of three months. It shall conform to the requirements of AASHTO M 208.

**M3.03.3 Protective Seal Coat Emulsion.**

This material shall be a homogeneous emulsion consisting of coal tar pitch dispersed in water by means of a mineral colloid. Any separation or coagulation of its components shall be capable of being overcome by moderate stirring. It shall contain no asphaltic materials or chemical emulsifiers. When tested according to prescribed methods it shall meet the following requirements:

Department Designation:PSC-1	Minimum	Maximum
Percent Water (AASHTO T 55)		50
Percent Non-Volatile Matter (ASTM D 2939, Sec. 7)	48	
Percent Ash in Non-Volatile Matter (ASTM D 2939, Sec. 9)	20	45
Percent Solubility of Non-Volatile Matter in CS <sub>2</sub> (AASHTO T 44)	40	
Resistance to Water (ASTM D 466)	No blistering, Loss of Adhesion or Re-Emulsification	
Resistance to Petroleum Solvents (ASTM D 466 - with Solvents substituted for water)	No penetration and no Loss of adhesion	

#### **M3.04.2 Thermoplastic Asphalt Membrane.**

Only products\* pre-approved by the Department will be accepted for use. Composition and physical properties shall conform to the manufacturer's specifications for the material. All accessory materials used in the application of the thermoplastic asphalt membrane will be considered a part of this specification and shall conform to the manufacturer's requirements.

\*Refer to Department's pre-approved materials listing, obtainable from Research and Materials Section.

#### **M3.05.0 Hot Poured Joint Sealer.**

This sealer shall be composed of a mixture of materials which will form a resilient and adhesive compound capable of effectively sealing joints in concrete and shall conform to the requirements of AASHTO M 173.

#### **M3.05.1 Joint and Crack Sealer, Asphalt-Fiber.**

This material shall consist of a blend of asphalt cement (AC-20) and polyester fibers. The asphalt-fiber blend shall consist of 6% fiber mass to mass of asphalt.

#### **M3.05.3 Preformed Bituminous Joint Filler for Concrete.**

This material shall be a non-extruding and resilient bituminous type preformed expansion joint filler. It shall conform to the requirements of AASHTO M 213.

#### **M3.05.4 Hot Applied Bituminous Concrete Crack Sealer.**

This specification covers a hot applied crack sealer suitable for use in cement concrete and asphaltic concrete pavement. It shall conform to the requirements of Federal Specification SS-S-1401.

#### **M3.06.1 Coated Glass Fabric.**

This material shall be a coated glass fabric composed of inorganic glass fibers smoothly woven into an open mesh cloth. The coating shall be uniform and compatible with asphalt base or tar base compounds. The

finished material shall be free of visible external defects such as ragged or untrue edges, breaks, dents or cracks. It shall conform to the following requirements:

**Coated Glass Fabric**

Selvage

Unless otherwise specified, the selvage shall have a width of between 3 millimeters and 13 millimeters inclusive.

	Minimum	Maximum
Width of Roll	1 m $\pm$ 50 mm	1.2 m $\pm$ 50 mm
Gross mass per roll	2 kg	7 kg
Average net mass per square meter	43 g	
Coating on fabricated material per square meter	568 mg	

**Uncoated Glass Fabric**

	Minimum	Maximum
Average dry mass per square meter	40 g	
Composition of fabric	100% glass fibers	
Thread count per 25 millimeters of width:		
Warp	20 $\pm$ 1	24 $\pm$ 1
Filling	20 $\pm$ 1	24 $\pm$ 1

Where double strength fibers are used for the filling, the minimum requirement shall be 10 (-0 + 1) to 12 (-0 + 2).

**Breaking Strength** (ASTM Methods D 146 and D 1682)\*

Warp	32 kg minimum
Filling	32 kg minimum

\*To prevent the coated glass fabric from slipping out from between the jaws of the tension testing machine, insert a thin strip of soft gasket rubber between the fabric and each of the four jaws of the machine before clamping in position.

**M3.09.0 Asphalt Pipe Coating.**

The material shall conform to the requirements of AASHTO M 190.

**M3.10.0 Asphalt Anti-Stripping Additive.**

This specification provides for an additive to asphalt to assist in the coating of wet aggregate and to increase the resistance of the bituminous coating to stripping in the presence of water. The additive shall be chemically inert to asphalt (heat stable) and when blended with asphalt shall withstand storage at a temperature of 205 °C for extended periods without loss of effectiveness.

Composition: Anti-stripping compound shall be an organic chemical compound free from inorganic mineral salts or inorganic mineral soaps. It shall contain no ingredient harmful to the bituminous material or to the operator, and shall not appreciably alter the specified characteristics of the bituminous material.

Anti-stripping additive shall be incorporated and thoroughly dispersed in the bituminous material in an amount equal to the percent by mass established by the Department. This percent is based on the efficiency of the additive as determined by laboratory tests.

**Test Requirements:**

**1. Heat Stability**

Anti-stripping compound shall be tested for chemical inertness to asphalt (heat stability). The compound shall retain its effectiveness after heating in asphalt according to the prescribed method for 24 hours at 177 °C.

**2. Resistance to Stripping**

Treated bitumen shall be required to coat wet aggregate and to retain at least 90% of the coating after 24 hours static immersion. There shall be no loss in retained coating after immersion has been extended to one week.

**3. Concentration of Additive**

The percent of additive to be incorporated in the bituminous material shall be specified by the Department based on laboratory tests using Rhyolite as a test aggregate. No modification of the established additive concentration shall be made because of the use of hydrophobic aggregate. The Department reserves the right to establish a minimum percent of additive required.

**M3.11.00 Class I Bituminous Concrete.**

**M3.11.01 General.**

These mixtures shall be composed of mineral aggregate, mineral filler (if required), bituminous material, and reclaimed asphalt pavement (RAP). The use of RAP shall be at the Contractor's option unless otherwise provided by the special provisions of the contract.

Plants producing recycled mix shall be equipped so that they can properly proportion, blend and mix all components of a recycled mixture so that the end product is in conformance with the designated job-mix formula.

**M3.11.02 Composition of the Mixture.**

The mineral aggregate, filler (if required), bituminous material, asphalt modifier (if required) and RAP shall be proportioned and mixed to conform with the designated mixture as tabulated in Table A hereinafter.

**M3.11.03 Job-Mix Formula.**

The composition limits in Table A are master ranges of tolerances of materials in general. In order to obtain standard texture, density and stability, the Contractor will furnish to the Engineer a specific job-mix formula for the particular uniform combination of materials and sources of supply to be used on each project. The job-mix formula for each mixture shall establish a single percentage of aggregate passing each required sieve size, a single percentage of bituminous material to be added to the aggregate and for batch plants, the number of seconds for dry mixing time and the number of seconds for wet mixing time. AASHTO T 195 (Ross Count) with a coating factor of 98% will be used when necessary to evaluate proper mixing time. The job-mix formula shall also specify a single source or uniform blend of particular sources for fine aggregate, a single source for each nominal size of coarse aggregate, a single source of supply for mineral filler and sources for asphalt.

The use of RAP will be permitted at the option of the Contractor and provided that the end product is in conformance with the designated job-mix formula. The proportion of RAP to virgin aggregate shall be limited to a maximum of 40% for drum mix plants and 20% for modified batch plants. The maximum amount of RAP for surface courses shall be 10% except no RAP will be allowed in the open graded friction course (OGFC).

Two or more job-mix formulas may be approved for a particular plant; however, only material conforming to one job-mix formula will be permitted to be used on any given calendar day. The job-mix formula shall bind the Contractor to furnish paving mixtures not only within the master ranges, but also conforming to the exact formula thus set up for the project, within allowable tolerances as follows:

**For Table A Mixes**

4.75 mm and larger sieve	± 7.0%
2.36 mm and smaller sieves, except 75 µm	± 4.0%
Passing 75 µm sieve	± 2.0%
Asphalt	± 0.4%

**For Table B Mixes**

4.75 mm and larger sieves	± 5.0%
2.36 mm and smaller sieves, except 75 µm	± 3.0%
Passing 75 µm sieve	± 1.0%
Asphalt	± 0.3%

**Table A****Percent by Mass Passing  
Sieve Designation**

Standard Seives	Base Course	Binder Course	Dense Binder Course	Top Course	Modified Top Course	Dense Mix	Surface Treatment
50 mm	100						
25 mm	55 - 80	100	100		100		
19 mm		80 - 100	80 - 100		95 - 100		
16 mm				100			
12.5 mm	40 - 65	55 - 75	65 - 80	95 - 100	75 - 90	100	
9.5 mm				80 - 100	60 - 75	80 - 100	100
4.75 mm	20 - 45	28 - 50	48 - 65	50 - 76	40 - 60	55 - 80	80 - 100
2.36 mm	15 - 33	20 - 38	37 - 51	37 - 54	32 - 44	48 - 63	64 - 85
1.18 mm				26 - 40	24 - 34	36 - 49	46 - 68
600 µm	8 - 17	8 - 22	17 - 30	17 - 29	16 - 26	24 - 38	26 - 50
300 µm	4 - 12	5 - 15	10 - 22	10 - 21	8 - 18	14 - 27	13 - 31
150 µm				5 - 16	4 - 13	6 - 18	7 - 17
75 µm	0 - 4	0 - 5	0 - 6	2 - 7	2 - 7	4 - 8	3 - 8
Bitumen	4 - 5	4.5 - 5.5	5 - 6	5.5 - 7.0	5.0 - 6.0	7 - 8	7 - 8

\*Percentages shown in table above for aggregate sizes are stated as proportional percentages of total aggregate for the mix.

Unless authorized by the Engineer, no Job-Mix Formula will be approved which specifies:

More than 45% passing 2.36 millimeter for Top Course and Dense Binder Course.

More than 38% passing 2.36 millimeter for Modified Top Course.

More than 55% passing 2.36 millimeter for Dense Mix.

Less than 4% passing 75 micrometer for Top Course.

Less than 6% bitumen for Top Course.

Should a change of sources of materials be made, a new job mix formula shall be established by the Contractor before the new material is used. When unsatisfactory results or other conditions make it necessary, the Engineer may establish a new job-mix formula.

The aggregate will be accepted in stockpile at the plant site. The bituminous material will be accepted on

certification.

If the Contractor elects to furnish bituminous concrete from more than one plant, the job-mix formula must be adhered to by all plants.

**Table B**  
**Specifications for Open-Graded Friction Course (OGFC)**  
**and Open-Graded Friction Course - Modified (OGFC-M)**

Seive Designation	OGFC
16 mm	--
12.5 mm	100
9.5 mm	90 - 100
4.75 mm	30 - 50
2.36 mm	5 - 15
75 $\mu$ m	1 - 3
% Bitumen (AC-20)	6.0 - 7.0

All relevant provisions of M3.11.00 shall apply to OGFC with exceptions as hereinafter noted:

- a) Mixing temperatures for OGFC shall be between and 107 °C and 121 °C. This will require close control over aggregate drying and asphalt storage temperatures so that the resulting mix temperatures will fall within the limits stipulated herein.
- b) Placing temperature for OGFC shall be between and 107 °C and 121 °C. As placing temperature is a critical factor in this type of mix, hauling time to the project should be limited so as to avoid mix temperature from dropping below the required minimum. All mixes should be covered during transportation.
- c) Tack coat – *Asphalt Emulsion*, RS-1 when needed, applied at the rate of 0.25 liters per square meter.
- d) Silicone shall be added to the asphalt in the amount of 1.5 grams per cubic meter of asphalt.
- e) Anti-stripping additive shall be added if indicated by laboratory tests and only as directed by the Engineer.
- f) Mix meeting the requirements of this specification shall be placed to a compacted thickness of 19 millimeters to 25 millimeters for OGFC.

**Weather Limitations**

No mix shall be placed on wet or damp surfaces. When surface and ambient temperatures are 15 °C and rising, the Contractor shall use mix prepared and placed in accordance with the specified requirements of the mix hereinbefore designated as OGFC.

Irrespective of any temperature requirements, no mix conforming to the requirements of these specifications shall be placed after October 31 or before May 1 of any year.

**M3.11.04 Mineral Aggregate.**

**A. Coarse Aggregate.**

The coarse mineral aggregate shall be clean, crushed rock consisting of the angular fragments obtained by breaking and crushing shattered natural rock, free from a detrimental quantity of thin or elongated pieces, free from dirt or other objectional materials, and shall have a percentage of wear, as determined by the Los Angeles Abrasion Test (AASHTO T 96), of not more than 30. It shall be surface dry and shall have a moisture content of

not more than 1/2% after drying. The use of crushed gravel stone will not be permitted.

**B. Fine Aggregate.**

The fine aggregate shall consist of one of the following:

- a) 100% Natural Sand
- b) 100% Stone Sand
- c) A blend of sand and stone screenings the proportions of which shall be approved by the Engineer
- d) A blend of natural sand and stone sand.

Natural sand shall consist of inert, hard, durable grains of quartz or other hard, durable rock, free from topsoil or clay, surface coatings, organic matter or other deleterious materials. When the primary source of material, passing the 75  $\mu\text{m}$  sieve, is obtained from natural sand, these fines must be approved prior to use.

Stone sand shall be a processed material prepared from stone screenings to produce a consistently graded material conforming to specification requirements.

The stone screenings shall be the product of a secondary crusher and shall be free from dirt, clay, organic matter, excess fines or other deleterious material.

The fine aggregate as delivered to the mixer shall meet the following requirements:

Sieve Designation	Percent Passing	
	Minimum	Maximum
9.5 mm	95	100
2.36 mm	70	95
300 $\mu\text{m}$	20	40
75 $\mu\text{m}$	2	16

In the fine aggregate sieve analysis (passing 2.36 millimeters), the amount between two successive sieves (1.18 mm, 0.670 mm, 300  $\mu\text{m}$  and 150  $\mu\text{m}$ ) shall not exceed 33% of the fine aggregate total.

Plants that experience a large variation in the quality and gradation of their primary fine aggregate sources and have difficulty in consistently providing fine aggregate that conforms to the requirements of this specification, shall be equipped with an approved fine aggregate system for processing fine aggregate that *will* meet the requirements of this specification.

**C. Reclaimed Asphalt Pavement (RAP)**

Reclaimed Asphalt Pavement (RAP) shall consist of the material obtained from highways or streets by crushing, milling or planing existing pavements. This material shall be transported to the mix plant yard and processed through an approved crusher so that the resulting material will contain no particles larger than 38 millimeters. The material shall be stockpiled on a free draining base and kept separate from the other aggregates. The material contained in the stockpiles shall have a reasonably uniform gradation from fine to coarse and shall not be contaminated by foreign materials.

**D. Processed Glass Aggregate (PGA)**

The use of Processed Glass Aggregate (PGA) meeting the requirements of M2.01.8 may be added at a maximum addition rate of 10% mass. This addition will only be allowed in base and binder bituminous concrete mixtures. PGA in mixes containing reclaimed asphalt pavement (RAP) will be considered as part of the overall allowable mass of RAP in the mix. If PGA is used in the mix a separate aggregate bin shall be used and the use of lime as an anti-stripping agent will be required.

**M3.11.05 Mineral Filler.**

Mineral filler shall consist of approved Portland Cement, limestone dust, hydrated lime, stone float or stone dust. Stone dust shall be produced from crushed ledge stone and shall be the product of a secondary crusher so processed as to deliver a product of uniform grading. Mineral filler shall completely pass a 300 micrometer sieve and at least 65% shall pass a 75 micrometer sieve.



### **M3.11.06 Bituminous Materials.**

**A.** The asphalt cement for the mixture shall be the grade designated by the Engineer and shall conform to the requirements of M3.01.0. When required an approved anti-stripping additive conforming to M3.10.0 shall be added to the asphalt cement.

**B.** Bituminous material for the tack coat on the existing surface, where required and specified, shall be emulsified asphalt, grade RS-1 conforming to M3.03.0.

**C.** For any bituminous mixture containing RAP, the Contractor shall submit in addition to the Job-Mix formula, the amount and type of asphalt modifier to be added to the mixture to restore the asphalt properties of the RAP to a level that is reasonably consistent with the requirements of current specifications for new asphalt. The restored asphalt when recovered by the Abson Method from the recycled mixture shall have a minimum penetration at 25 °C of 50 and a maximum absolute viscosity at 60 °C of 800 pascal seconds.

Only asphalt cement, grades AC-5, AC-10, AC-20 or a blend thereof will be used as modifiers and shall meet the requirements of M3.01.0.

### **M3.11.07 Plant Requirements.**

Bituminous concrete conforming to these specifications shall be produced either in a batch plant or a drum mix plant. Mix plants shall comply with the following:

#### **Requirements for Batch Plants**

##### **A. Plant Scales**

1. Scales for measuring materials into the mixtures shall be springless dial or digital type and shall be of standard make and design. Scale graduations and markings shall be plainly visible and dials must be so located as to be easily readable from the operator's normal workstation by direct sight, through repeating dials or digital displays. Parallax effects shall be reduced to the practical minimum with clearance between indicator index and scale graduations not exceeding 1.5 millimeters. Dials shall be equipped with a full complement of adjustable index pointers for marking the required mass of each material to be weighed into the batch.

2. Digital scales will be either electronic/mechanical (load cell and lever system) or fully electronic (all load cell). Digital indicators shall be of standard make and design. Scale graduations and capacity shall be plainly visible on the faceplate of the indicator, if panel mounted. If the unit is of desktop or wall-mount variety, a data sticker shall be located on the side of the unit. Indicators must be located as to be easily readable from the operator's normal workstation by direct sight.

3. Bitumen scales shall be accurate to 0.05%, have minimum graduations not greater than 0.025%, and must be readable and sensitive to 0.0125% or less. Scales for any box or hopper shall be accurate to 0.5%, have minimum graduations not greater than 0.5% and must be readable and sensitive to 0.25% or less. The preceding percentages for both bitumen and aggregate scales are to be based on the maximum total batch mass of the mixtures.

##### **B. Truck Scales**

Truck scales shall be located on the plant property and shall be within a reasonable walking distance for the plant inspector. Scales shall be accurate to within  $\pm 0.5\%$ .

##### **C. Testing of Scales.**

a) All plant scales, including truck scales, shall be tested at the expense of the producer by a competent scale technician as follows:

1. Annual prior to use in Department work.
2. At intervals of not more than 90 calendar days.
3. At any time ordered by the Engineer.

b) Where appropriate and at the direction of the Engineer, an approved cradle or platform for each scale and at least ten (10) standard 22 kilogram test masses shall be provided for testing scales whenever directed by the Engineer. The use of a set of test masses for two (2) or more plants will be permitted only when they can be made readily available with no more than one hour's notice.

##### **D. Automated Batching.**

###### **1. Automatic Proportioning.**

All Batch Type mixing plants furnishing bituminous concrete mixtures for contracts which are financed fully or partially with Federal Funds, or 100% State Contracts requiring in excess of 13 500 metric tons shall be equipped with approved automatic proportioning devices. Such devices shall include equipment for accurately proportioning batches containing the various components of the mixture by mass in the proper sequence and for controlling the sequence and timing of mixture operations. Interlocks shall be provided which will hold or delay the automatic batch cycling whenever the batched quantity of any component is not within the specified mass tolerance, when any aggregate bin becomes empty or when there is a malfunction in any portion of the control system. The mass setting and time controls shall be so equipped that they may be locked when directed by the Engineer.

## **2. Automatic Recordation.**

Recordation equipment shall be provided in all plants producing bituminous concrete under the provisions requiring automatic proportioning. Each recorder shall include an automatic printer system. The printer shall be so positioned that the scale dial or the digital display and the printer can be readily observed at one location by the plant inspector and the plant operator. Use of repeating dials or digital displays or an additional printer to achieve this condition will be permitted. The printer will print, in digital form, on a delivery ticket the following data:

- a) Date mixed.
- b) Time of batching.
- c) Tare mass of aggregate box.
- d) Tare mass of bitumen bucket.
- e) Accumulative or *net masses* as batched for each bin with a batch total for all net ingredients.
- f) Mass of bitumen.
- g) Total mass of mix in truck (pay metric tonnage).

This printed ticket will be used in lieu of truck scale masses.

## **3. Equipment Failure.**

If at any time the automatic proportioning or recording system becomes inoperative, the plant will be allowed to batch materials manually for a period not in excess of 2 working days. Manual batching for longer periods will require written permission of the Engineer.

## **4. Batching Controls.**

a) The batching controls shall meet the following delivery tolerances with respect to the various components weighed in each batch:

Tare mass of aggregate box	± 0.5% of total batch mass
Tare mass of bitumen bucket	± 0.1% of total batch mass
Individual aggregate components	± 1.0% of total batch mass
Combined aggregate components	± 1.5% of total batch mass
Mineral filler	± 0.5% of total batch mass
Asphalt	± 0.1% of total batch mass

Truck loads consisting of more than one batch will be deemed acceptable if the average of the deviations of any of the components of the several batches which comprise the load do not exceed the specified tolerance.

- b) The total mass of the batch shall not vary more than plus or minus 2% from the theoretical design mass.
- c) If directed by the Engineer, provision shall be made for locking controls against tampering.

## **E. Testing Facilities.**

A weatherproof building or room shall be furnished at the site of the producing plant suitable for the housing and use of equipment necessary to carry on the various tests required and for recording and processing test results. This building shall be for the exclusive use of the Engineer or his/her representative for testing and recording purposes. The building or room shall have a least dimension of 2.1 meters and a minimum of 20 square meters. Windows and doors shall be adequately screened. Satisfactory lighting and heating shall be provided for a 24 hour day and the facility shall be supplied with water. The room shall have adequate ventilation and be air conditioned. A table, chairs, desk, work bench, file cabinet, electronic calculator and a minimum of two 2.7 kilogram fire extinguishers shall be provided.

Provision shall be made for the safe performance of extraction test determinations by providing an adequate exhaust fan and/or hood system and a suitable means of disposing of used solvent and other waste. All to be in conformance with current OSHA, EPA, and DEP standards.

If the Engineer permits, the testing facility may be part of another building in which case it shall be entirely partitioned off from the remainder of such building.

Testing equipment conforming to current AASHTO standards and meeting the approval of the Engineer shall be furnished as follows and installed in the building for use in testing the materials (and mixtures) supplied by the Plant for the work:

- 1 Approved Rotary Extractor or approved Vacuum Extractor (minimum 3000 gram capacity).
- 1 Coarse Aggregate Sieve Shaker, power driven with a minimum clear sieve area of 0.209 square meters. The shaker shall be attached to a firm anchorage.
- 1 Each of the following square opening screens for coarse aggregate shaker: 50 mm, 37.5 mm, 25 mm, 19 mm, 12.5 mm, 9.5 mm, 4.75 mm, and 2.36 mm.
- 1 Fine Aggregate Sieve Shaker, power driven and independent of coarse aggregate shaker, for 200 millimeter minimum diameter sieves.
- 1 Each of the following standard 200 millimeter minimum diameter square opening sieves: 19 mm, 16 mm, 12.5 mm, 9.5 mm, 4.75 mm, 2.36 mm, 1.18 mm, 600  $\mu$ m, 300  $\mu$ m, 150  $\mu$ m, and 75  $\mu$ m with pan and cover.
- 1 Sample Splitter with a minimum capacity of 0.03 cubic meters. It shall be of the clam shell type and the chute width shall be adjustable from a minimum of 12.5 millimeters up to 50 millimeters.
- 1 Solution Balance, 20 kilogram capacity, weighing directly to 1 gram, with two weighing beams and a taring beam: tare capacity to be 2 kilograms; weight beams to read 1000 grams by 100 gram divisions and 100 gram by 1 gram divisions. Additional matching weights (one - 1 kg, two - 2 kg, and one - 5 kg, and one - 10 kg) shall be provided to fulfill the capacity of 20 kilograms. The platform to be 280 millimeter diameter. An electronic, direct reading, top loading, 20 kilogram minimum capacity balance with a precision of 0.1 gram may be substituted for the solution balance.
- 1 Approved scale with a minimum capacity of 2000 grams and a sensitivity of 0.50 grams, or an electronic, top-loading, balance with a capacity of 2000 grams minimum, and reading to 0.1 gram.
- Approved dial Thermometers, range of 10 °C to 260 °C.
- Approved Hot Plates.

Approval of a plant will be contingent upon approval of the aforementioned requirements for Plant Laboratory, including the building and appurtenances, furnishings, facilities including heat, light, power and water, the testing equipment and any other incidentals.

#### **F. Sampling Facilities.**

Adequate and convenient sampling facilities shall be provided which allow the Inspector to obtain representative samples from the full width and depth of the discharge area of each aggregate bin. The sampling tray shall be structurally supported during the sampling operation. Access to the sampling facilities shall be provided requiring no more difficulty than that to climb a ladder leading to a secure platform with railings.

#### **G. Preparation of Mixtures.**

##### **1. Preparation of Asphalt Cement.**

The temperature of the bituminous materials when placed in the mixer shall be not less than 135 °C nor more than 190 °C.

##### **2. Preparation of Mineral Aggregate.**

All aggregates shall be thoroughly dried and heated before entering the mixer. The temperature of the aggregates shall be controlled so that the temperature of the completed mixture shall be within the range specified below under G.3, Preparation of Bituminous Concrete Mixtures.

**3. Preparation of Bituminous Concrete Mixture.**

The mineral aggregate, prepared as prescribed above, shall be combined and conveyed into the mixer in the proportionate amounts of each aggregate required to meet the job-mix formula. The required quantity of asphalt cement shall be measured by mass, or approved metering device.

The mixture shall be made by first charging the mixer with the required amount of mineral aggregate and mineral filler. After the materials have been thoroughly mixed, the asphalt cement shall be added and the mixing continued for a period of time sufficient to produce a homogenous mixture.

The ingredients shall be heated and combined in such a manner as to produce a mixture which shall be at a temperature, when discharged, of not less than 135 °C, nor more than 190 °C.

**4.** The temperature of mixture containing RAP as discharged from the modified batch plant shall be within the range of 130 °C to 150 °C. Moisture content of the mixture at discharge shall be no greater than 1.0% by mass. All aggregate particles shall be completely and uniformly coated. The recycled mixture shall not contain any visible chunks of unprocessed RAP. The recycled mixture shall be capable of being spread and compacted to a density that is not less than 95% of the density obtained from laboratory compaction of a mixture composed of the same materials in like proportions.

**Requirements for Drum Mix Plants**

The basic components of the drum mix plant are:

Aggregate cold-feed bins

Conveyer and aggregate weighing systems

Drum mixer

Asphalt storage metering system

Hot-mix conveyer

Storage and surge silos

Central Control Panel

**A. Aggregate Cold-Feed Bins.**

The number and capacity of the cold-feed aggregate bins shall be sufficient to keep the plant in continuous operation. There shall be one cold-feed bin for each stockpile of material to be used. Stockpiles shall be established on clean free draining surfaces and shall be so constructed as to minimize segregation. The bins shall be designed to prevent overflow of material from one bin to another. The fine aggregate bin compartments shall be equipped with a vibrator or other anti-bridging device which is automatically actuated when bridging of the material occurs and which automatically shuts off when continuous material flow is restored.

An interlocking automatic cold-feed shut-off shall be provided so that all production is stopped if flow from any one bin is interrupted for more than five seconds.

**B. Mineral Filler Bin.**

The requirements for a mineral filler bin shall be optional. Mineral filler bin shall be fed from a separate bin provided with a device that controls the feed at adjustable rates accurately and uniformly. The bin shall be equipped with an interlocking device to shut off all production if the flow of mineral filler is stopped. It shall also be equipped with an automatic anti-bridging device.

**C. Aggregate Feeder Control.**

The plant shall have a mechanical system for feeding the aggregate from each cold bin accurately and uniformly in its proper proportion onto a common collecting belt. The system shall be so designed and production is automatically stopped if the flow of material from any one of the bins is interrupted for more than five seconds.

Each aggregate and mineral filler bin shall have an adjustable feed rate control.

The accuracy of the aggregate feeder control system shall be such that the total variations for all materials being drawn per interval of time shall not exceed 1.5% of the total mass of bituminous mixture per interval of time. Where the separate addition of mineral filler is required, the variation shall not exceed 0.5% on the same basis as stated above for aggregates.

For purposes of accurate weight and gradation checks, and calibration of the aggregate proportioning system, suitable means shall be provided for conveniently obtaining representative samples of the full flow of material from each cold feed and the total cold feed. A sampling device for diverting the full flow of the combined aggregate into a suitable container shall be provided.

Prior to entering the drum mixer the combined aggregate on the common feeder belt shall pass through a 50 millimeter scalping screen.

**D. Aggregate Weighing Systems.**

All aggregates including mineral filler, if required, shall be weighed by a continuous weighing device either as it is proportioned by the individual feeders or after all materials have been deposited on the common belt. The weighing device for weighing the total material accumulated on the common belt shall be located so that the mass reading is obtained after the material has been passed through the 50 millimeter scalping screen.

Belt scales shall meet the requirements of the National Bureau of Standards Handbook 44. When tested, the weighing system shall have an accuracy of 0.5%.

All weighing devices shall be installed in accordance with the manufacturer's recommendations.

The weighing devices shall be capable of displaying at the control panel, the aggregate mass flow, in metric tons per hour, and shall continuously accumulate the masses of material during the day's production.

**E. Aggregate Moisture Compensator.**

Moisture content of the aggregate shall be determined manually or electronically and a moisture compensation device shall be capable of electronically changing the wet aggregate mass to dry aggregate mass.

**F. Reclaimed Asphalt Pavement (RAP).**

The plant shall be equipped with a separate bin suitably located for introduction into the drum mixer. The RAP bin shall be equipped with an interlocking device for automatically stopping production if the RAP bin becomes empty or flow is stopped for any reason.

A weighing device shall be located on the RAP conveyor for continuous weighing of the RAP. Also a moisture compensator shall be included in the RAP delivery system to compensate for the moisture in the RAP.

**G. Drum Mixer.**

The drum mixing unit shall be approved by the Engineer and shall be a revolving type that continuously agitates and mixes the bituminous material. It shall have an automatic burner control and be capable of producing a uniform mix within the job specifications.

An automatic temperature recording device that continuously records the mix temperature shall be located in the area of discharge and the data transmitted to the control panel.

**H. Bituminous Metering System.**

The bituminous material shall be introduced into the drum mixer by a metering system that is capable of accurately and continuously measuring the quantity and temperature of the material being introduced. The temperature recording device shall be located so as to record the temperature of the bituminous material prior to entry into the mixer.

The metering system shall be capable of introducing the proper amount of material into the mix, accurate to  $\pm 0.1\%$  based on the total mass of the mix.

The bituminous metering system shall be interlocking with both the aggregate and RAP weight control system so that any change in the aggregate or RAP rate of flow will automatically trigger a change in the bituminous material rate of flow so as to maintain the correct proportions. Also, any interruption in the flow of bituminous material to the mixer shall stop all production. Means shall be provided for conveniently and safely diverting the flow of bituminous material into a suitable container for checking the accuracy of the metering system. A temperature compensating device shall be installed in the metering system to correct the quantity of bituminous material to 15.6 °C.

The bituminous material flow shall be continuously displayed at the central control panel in metric tons per hour or as the corresponding percentage of the total mix.

**I. Hot Mix Conveyor.**

The mix will discharge onto a hot mix conveyor that carries the mix to a surge silo. The temperature of the mix when discharged onto the conveyor shall be not less than 135 °C nor more than 163 °C. Means shall be provided for conveniently and safely obtaining a representative sample of the mix as it is discharged from the mixer or from the

hot mix conveyer.

The hot-mix conveyer shall be designed so as to prevent any segregation and excessive temperature variation of the mix as it is transported and dumped into the surge-silo.

**J. Surge and Storage Silos.**

The plant shall be equipped with sufficient surge and storage silos to accommodate the temporary storage of different mixes and to minimize any production interruptions.

Surge-Storage Silos shall be approved in accordance with the following requirements:

a) All bins shall be designed and equipped so that there will be no segregation of the mix at the time of loading, during storage or at time of discharge. The Engineer reserves the right to reject any material when there is any indication that the material is not in conformance with specifications.

b) The holding bins, together with all equipment and methods pertaining to their use, shall be subject to approval by the Engineer. The use of coatings on the internal surface of the bins shall not be permitted. The use of additives to the bituminous concrete mixes will be permitted only with the approval of the Engineer.

c) Unless otherwise permitted by the Engineer, the mixtures shall not be stored in surge and storage bins longer than the following:

<b>Type of Bin</b>	<b>Maximum Holding Time</b>
Unheated and not insulated	2 hours
Unheated, but insulated (may have heated gate)	15 hours
Insulated and heated	24 hours

d) Surge silos for the temporary storage of mix during a day's production shall always be maintained above the one-quarter full level.

**K. Proportioning Controls.**

All proportioning controls for aggregate, mineral filler, bitumen and RAP shall be electronically interlocked so that any interruption of more than 5 seconds in the flow of one component will automatically stop all production. The central control panel shall be equipped with a master control which will increase or decrease the production rate without having to reset the individual controls for each change in the production rate.

a) Each aggregate and mineral filler feeder shall have an adjustable rate control. The controls shall maintain the accuracy of the aggregate feeders to  $\pm 1.5\%$  of the total mass of the bituminous mix per interval of time and the mineral filler feeder to  $\pm 0.5\%$  of the mass of the bituminous mix per interval of time.

The flow rates of the aggregate and mineral filler shall be continuously displayed at the control panels in metric tons per hour and continuously accumulated for each day's production.

b) Provisions shall be made for a moisture compensating device that will electronically correct combined wet aggregate mass to dry aggregate mass.

c) The bitumen control shall be capable of presetting the bitumen content directly as a percentage of the total mass of the mix in increments of 0.1%. The bituminous metering system shall be coupled with the aggregate and RAP feeder systems to automatically maintain the required proportions as the aggregate and RAP flow vary.

The bituminous flow rate shall be continuously displayed at the central control panel in metric tons per hour and continuously accumulated.

d) At the start of each production season all plant controls necessary to the production of specification mix shall be calibrated. The method of calibration shall be in accordance with the plant manufacturer's instructions and shall be subject to approval by the Engineer.

Calibration points for the delivery of each type of mix used by the Department shall be determined.

e) The central control panel shall be equipped with an automatic digital recording device, that on a continuing specified interval and on demand, records the mass of aggregate from each bin or the accumulated mass of all aggregates on the common belt, mineral filler and RAP, if used, and bitumen. All print-outs shall show time and date and shall be clearly legible. Copies shall be provided to the Engineer.

**L.** All plant controls shall be capable of being locked to prevent tampering. After calibration, no changes

will be made to the equipment or operating procedures without the approval of the Engineer.

**M. Testing Scales.**

All plant scales, including truck platform scales shall be subject to the same testing requirements as found under this Section M3.11.07C, Requirements for Batch Plants, Testing of Scales.

N. The plant shall be designed and operated to meet all current Federal and State air quality requirements.

**O. Portable Drum Mix Plants.**

Whenever a plant is moved from one location to another, it shall be recalibrated in accordance with this Section M3.11.07 K(d).

**P. Testing Facilities.**

Testing facilities shall conform to this Section M7.11.07, Plant Requirements for Batch Plants, E, Testing Facilities.

**M3.11.08 Inspection.**

The Engineer or his/her authorized representative shall have access at any time to all parts of the plant for:

1. Inspections of the conditions and operations of the plant.
2. Confirmation of the adequacy of the equipment in use.
3. Verification of the character and proportions of the mixture.
4. Determination of temperatures being maintained in the preparation of the mixture.
5. Inspection of incidental related procedures.

**M3.11.09 Composition and Compaction Acceptance Tests.**

Where plant inspection is maintained, the material will not be considered acceptable for use unless the specified tests from samples obtained at the production plant indicate conformance to the approved job mix formula.

The applicable tolerances defining reasonably close conformity with the specifications (as outlined in Subsection 5.03) shall be the amount of bitumen, the percentage by weight passing 2.36 millimeter and 75 micrometer sieves as specified under M3.11.03, Table A.

For determination of pavement density the Nuclear Density Method ASTM D 2950 and/or Bulk Specific Gravity Method AASHTO T 166 shall be used. Where AASHTO T 166 is used, samples for the full depth of the course being laid shall be taken from the mixture incorporated in the work after finishing operations have been completed and the pavement has cooled. The Contractor shall have suitable coring equipment available in order that the required number of samples (150 millimeter cores) may be taken. At least one such sample shall be taken from each project containing 2500 metric tons of mixture. In projects containing more than 2500 metric tons of mixture, at least one sample shall be taken for each 2500 metric tons; except that any additional number of samples shall be taken as may be deemed necessary by the Engineer.

These samples will be taken by the Contractor in the presence of the Engineer on the day following the placement of the course, weather permitting.

**M3.12.0 Bituminous Concrete Curb, Types 1, 2 or 3.**

The Bituminous Concrete for curbing shall be Class I conforming to the applicable requirements for Dense Mix (See M3.11.03, Table A).